great activity, and it needs but the exposure of a few days or even of a few hours in some plants to allow for very marked development of the stems, leaves, and flowers.

Another point of interest in the present connection is the fact that such notable differences are found between the temperatures of the subterranean and aerial portions of the bodies of plants at almost all seasons. During June, 1902, the shoots of herbaceous plants were in an atmosphere that varied between 8° C. (46.5° F.) and 34° C. (92.5° F.), while the roots were between 8° C. (46.4° F.) and 13° C. (55.4° F.). As the maxima and minima were not synchronous the actual difference between the temperature of twigs and leaves on the upper part of the plant, and roots on the lower amounted to as much as 22° C. (nearly 47° F.) at certain times of the day. Such conditions occur, though slightly less accentuated, during the entire summer in this locality. It is evident without further discussion that such differences in the temperature conditions of the two poles of the plant must exert a more or less important influence on the transport of fluids and solutions from one part of the plant to another. Referring to the previous discussion concerning the comparative transpiration and absorption during the day it is to be seen that the heightened temperature of the shoot must operate in a simple physical way to greatly augment the amount of water thrown off while the roots must take in water at the same time to meet the loss at a temperature as much as 47° F. lower.

During the movement of the water from the roots to the leaves of grasses and other low growing plants, a total distance of no more than 50 centimeters (20 inches) may be traversed, occupying a matter of a few minutes, or an hour at most, during which time the temperature is raised the above amount. The warming of the liquid as it passes upward through the living and nonliving cells is attended by alterations in its solubility of mineral and organic substances and by a decreased capacity for holding gases in solution. The downward movement of solutions of sugars, acids, and nitrogenous substances from the leaves encounters the opposite set of conditions. This movement takes place almost entirely by osmose and diffusion and is a much more complicated process, both chemically and physically, taking place in living cells only. The cooling of the liquid would entail alterations in its power of carrying substances in solution and would also alter its physical relations to the atmospheric gases present.

It may be said, in conclusion, that the facts disclosed as to the actual temperatures in the soil, the diurnal and seasonal changes therein, and as to the differences in temperature of the aerial and underground portions of plants can not fail to be of very great importance in the physical and chemical processes, upon which growth, cell division, nutrition, and propagation depend. The determination of the effect of differences in temperature between the roots and aerial shoots has received but little consideration from the physiologist and the geographer. A careful analysis of the conditions and results of experimental observations carried on with plants under artificial conditions, with the roots and shoots under abnormally similar temperatures, would no doubt result in the detection of many mistaken conclusions, especially in regard to absorption, translocation, and transpiration.

That soil temperatures and the relations of these temperatures to those of the air must be of very great importance in the cultivation of economic plants is self-evident, especially in species in which the desired useful portion is formed underground and receives storage material formed by the activity of the aerial organs. Thus, in the case of such plants as the potato, certain mineral substances are absorbed from the soil at a comparatively low temperature, carried aloft into the heated leaves, where they participate in activities resulting in the formation of sugars, starches, and other carbohydrates, perhaps some nitrogenous substances as well, and then these complex bodies are slowly diffused downward, with many accompanying chemical and physical modifications, to underground cool storage organs, where a condensation occurs and the products are stored in insoluble form in the tuber.

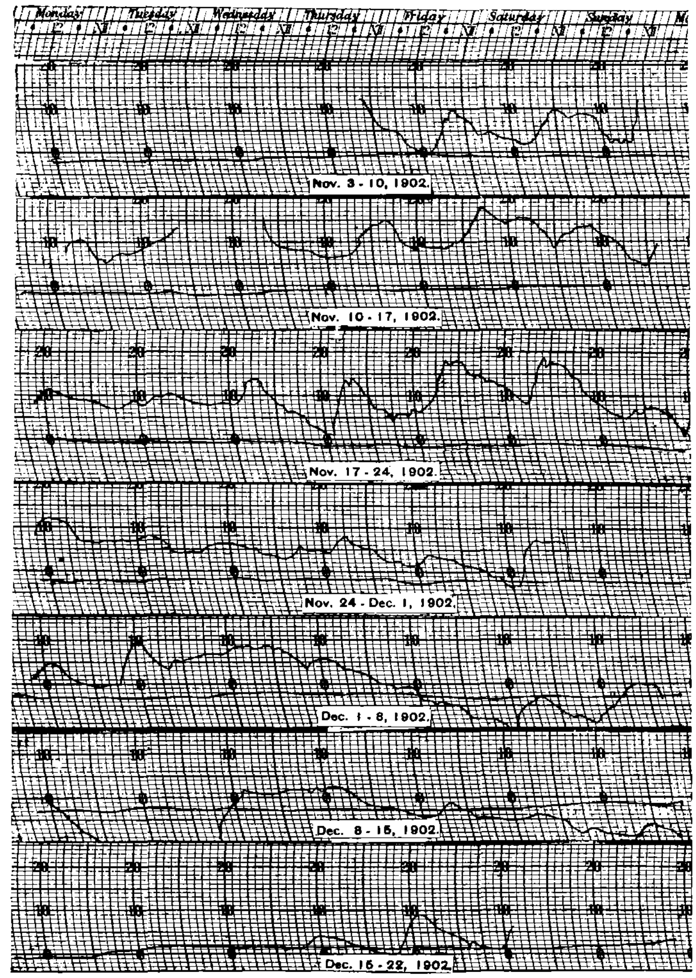

FIG. 7.—Tracings of thermographic curves of air, and of the soil at a depth of 30 centimeters (1 foot), November 3–December 15, 1902. The soil remained below the freezing point until December 8, when it began to rise steadily, and did not fall below freezing point during the remainder of the winter. Centigrade scale. The temperature of the air is shown by the uppermost of each pair of tracings.

NOTES AND EXTRACTS.

WEATHER BUREAU MEN AS INSTRUCTORS.

Mr. J. S. Hazen, Observer, Weather Bureau, Springfield, Mo., under date of August 1, incloses for inspection some manuscripts and charts covering a portion of the work done by him in the Drury College Summer School just closed. He states that he prepared eleven lectures in typewritten manuscript and also charts to illustrate them, and that these will probably be published in the series of articles in a leading newspaper of Springfield as a series for use in the winter schools. The work was undertaken at the request of Professor Childs for his class in physical geography. The class consisted of from ten to twelve teachers and the interest was such that they met twice a week at the Weather Bureau office, after office hours, during the summer school term of six weeks, usually taking an hour and a half for a lesson. A few members of the class had text-books on meteorology, the others had to depend on the office library and the text-books in physical geography. Much drill and practical work was imposed on the class, especially in drawing daily isotherms and isobars, rainfall charts, and annual temperature charts. The various instruments used in the Weather Bureau were fully explained. Cloud types were studied from photographs and from the tower of the building on an especially favorable day. Flattering enthusiasm was shown by the class, and all expect to use their practical knowledge in school work. No compensation was received, but the class gave a vote of thanks. The following is a list of the lectures:

No. 1.—Outline of course with history and work of Weather Bureau.

No. 2.—Exhibition and description of the meteorological instruments in general use by the Weather Bureau.

No. 3.—Class work in drawing isotherms and isobars.

No. 4.—Class work in drawing rainfall charts and annual temperature charts.

No. 5.—The weather map and forecasting.

No. 6.—Distinction between climate and weather.

No. 7.—Heat and how the air is warmed.

No. 8.—Cyclones and anticyclones.

No. 9.—Rainfall and clouds.

No. 10.—Optical phenomena of the sky.

No. 11.—General review and quiz.

THE METHOD ADOPTED IN CONSTRUCTING NORMALS.

Between July 6 and August 3, 1903, a number of memoranda were submitted to the Chief of Bureau relative to the proper method to be pursued in computing the daily normals of the various meteorological elements. Four different systems were described. The subject was referred to Prof. F. H. Bigelow, and certain conclusions and recommendations were approved by him and the Chief of Bureau as follows:

Before undertaking to form normals upon any of these systems (1, 2, 3, 4) the individual observations by months at least should be corrected (*a*) to the same elevation; (*b*) to the same shelter and observing system; (*c*) to the mean of twenty-four hourly observations; (*d*) to a long series of thirty standard years, January 1, 1873, to December 31, 1902.

The third system, viz, taking the means by months, plotting these, and drawing an annual curve and then interpolating along the curve for the individual dates, so as to get the normals for those dates is adopted as the method for getting normals for use in computing daily departures. On the other hand, the means of all the observed values for the same date such as January 1, January 2, etc., will be computed as hitherto and held for special study but not for regular use.

FROM NEW YORK TO CAPE TOWN.

In the winter of 1889–90 the Editor had the privilege of making a tour around the tropical portions of the North and South Atlantic oceans; much of his time was devoted to observations of the movements of winds and clouds and an attempt to gain new light on various features of the circulation of the atmosphere over these oceans. On the outward voyage from New York, we touched at Fayal, St. Vincent, Freetown, Elmira, Loanda, and reached Cape Town in January, 1890; returning thence we visited St. Helena, Ascension, Barbados, and Bermuda, reaching New York on May 27, 1890. Some account of this voyage and the meteorological work was given in the Editor's preliminary report of May, 1890, published in the American Meteorological Journal, October, 1891. This study was only a first feeble attack on this important problem. The fundamental question that still remains open is this: Is there an upper current moving steadily eastward or westward above any part of the equatorial portion of the Atlantic; to this problem anyone may contribute who sails from New York to Cape Town or in general anyone who crosses the equator at any latitude. It seems likely that there are both periodical and irregular variations in the general circulation due to the large influence of the continents, so that numerous voyages or a long, systematic series of observations will be needed in order to understand the subject. There is needed not only the kite work proposed by Mr. Rotch (Monthly Weather Review, April, 1902), but a long series of careful observations during voyages in equatorial regions.

Travelers and navigators who provide themselves with marine nephoscopes and cultivate continuous observations of clouds and winds as they pass from the north to the south, or vice versa, will inevitably add much to our knowledge. The masters of all vessels, both steamers and sailers, can well afford to encourage such work as this that conduces to make navigation safer and quicker.

The voyage from New York to Cape Town or Mauritius is most easily made on the freighters of the Union-Castle Line; from New Bedford to St. Helena and back one may take a New Bedford whaler. The voyage from Vancouver or San Francisco to New Zealand or Australia and the voyage from England or Portugal to Brazil and Argentina as well as to Cape Town and India or even the voyage from San Francisco to Valparaiso are matters of every day travel. Thus, it would seem that it should not be difficult to find many opportunities to secure continuous series of cloud observations or meridional sections of the atmospheric currents in the North and South Temperate zones and the intermediate equatorial regions.

A special interest in this class of work is stimulated by the consideration that the land hemisphere of the globe, having London as its north pole, includes both the Eastern and Western continents and the North and South Atlantic oceans, leaving the Pacific and the Antarctic, or the great Southern Ocean to make up the aqueous hemisphere. The North and South Atlantic are therefore comparatively small inclosed seas and the circulation of the atmosphere over them is largely a matter of annual interchange of air over land and ocean, plus the influence of the great whirls that move eastward from the North and South Pacific over the temperate portions of North and South America, respectively.

In connection with the above-mentioned study, we note the recent publication by the Union-Castle Mail Steamship Company (8 and 10 Bridge street, New York), of a beautiful Atlas of South Africa, illustrating the tracks of its steamers, the history, geography, and climate of the South African states. We know of no better publication as a source of information on these points. The study of geography in our modern schools includes climatology and history as essential factors, and both are well presented in this work, which is really more convenient than Greswell's Geography of Africa, south of the Zembesi. Americans in general probably have no adequate realization of the extent to which south Africa is filling up with a European citizenship. The coast plateau, 50 miles or less in width; the southern Karroo and the great Karroo, 250 miles wide and 2500 to 3500 elevation, and the northern Karroo with the lofty range of the Drakensberg (Sneeuwberg) up to 11,000 feet elevation, form attractive locations for plantations when once the proper steps have been taken to provide for water and irrigation. The atmosphere of south Africa, or the "Land of Sunshine," is remarkably pure, clear, and invigorating, apparently superior to that of the mountains of North America or Europe, owing to the great mass of pure ocean air that flows over it from southeast and southwest. The dryness of the air under high temperatures is quite agreeable and stimulates human activity, just as it does in our own dry regions. Cape Town, at latitude 34° south, has a mean of maxima in January of 82° and a mean of minima in July of 46°; mean annual, 62° F.; with which compare Wilmington and Charleston, at the corresponding northern latitudes on our Atlantic coast. Many of the climatic features